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ROBERTSON, C. R. 1969 Ph.D. Thesis, Stanford University.

ROBERTSON, J. M. 1959 On turbulent plane-Couette flow. Proc. *6th Midwestern Conference on Fluid Mechanics*, p. 169. University of Texas.

SAFFMAN, P. G. 1965 The lift on a small sphere in a slow shear flow. *J. Fluid Mech.* **22**, 385.

TAYLOR, G. I. 1923 The motion of ellipsoidal particles in viscous fluid. *Proc. Roy. Soc.* A **103**, 58.

TAYLOR, G. I. 1934 The formation of emulsions in definable fields of flow. *Proc. Roy. Soc.* A **146**, 501.

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